DOCUMENT RESUME

ED 194 751 CE 026 993

TITLE	Competencies for Articulation: Electronics.
INSTITUTION	Lincoln Public Schools, Nebr.: Southeast Community Coll., Lincoln, Nebr.
SPONS AGENCY	Nebraska State Dept. of Education, Lincoln. Div. of Vocational Education.
PUB DATE	[77]
NOTE	44p.: For related documents see CE 026 298-299, CE 026 991-995, and ED 151 563-565.
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Articulation (Education): *Competence: Competency Based Education: *Electronics: *Job Skills: Secondary Education: *Trade and Industrial Education: Two Year Colleges
IDENTIFIERS	Nebraska

ABSTRACT

Designed to help articulate vocational education student progress from one level of training to another and to employment, this electronics education guide lists competencies for soldering: performing basic operations with test equipment: servicing basic logic circuits: servicing DC power supplies: servicing solid state amplifiers: and servicing solid state oscillator circuits. The format for each competency is (1) task statement, (2) list of conditions and limitations for performance, and (3) criteria of acceptable performance. In a separate section, enabling tasks (activities necessary for developing a job skill) are listed for each competency with the suggestion that they may become daily or weekly lesson plans. A section on student outcomes contains a table correlating twenty-seven electronics occupations job titles with the competency lists and educational requirements, and tables correlating the competencies with high school credit and advanced college placement information (specifically for Nebraska programs). Also included are a glossary of terms and two forms: student progress chart and record of individual student skill achievement. (Tests of these competencies are available separately as CE 026 994. A procedures manual describing the process used to develop the competency lists and providing suggestions for adapting the materials to local situations is available separately, as are parallel competency lists for other curriculum areas--see note.) (KC)

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ED194751

COMPETENCIES FOR ARTICULATION

ELECTRONICS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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CE 026 993

An Exemplary Project in Vocational Education
Performed Pursuant to a Grant From The
NEBRASKA STATE BOARD FOR VOCATIONAL EDUCATION
Under the Provisions of Part D
of the Vocational Education Act of 1968

A Project of the
Lincoln Public Schools
Educational Service Unit No. 6
Southeast Community College

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PREFACE

More emphasis than ever is being given to educational competencies. The public is questioning the basic abilities of graduates and is demanding that schools be more accountable for student performance. Educators are determined to give a clear definition of what students are expected to learn.

Although many people are interested in competencies, few seem able to explain what they mean or give specific examples. Staff members of this project can. They have addressed an important problem — articulation between schools — in terms of the competencies students should have.

Defining competencies will not necessarily improve articulation. That improvement demands understanding, trust and cooperation among all concerned. Neither does the definition assume full-fledged, competency-based education — for that requires a complex system for instruction, assessment and certification that takes time to develop.

While these competency statements are not the whole picture, they are a significant achievement. If used properly, they will contribute to both better articulation and improved learning.

Ron Brandt
Executive Editor
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and Curriculum Development
Washington, D.C.

The Competencies for Articulation in this volume represent a significant opportunity for instructional improvement and continuity of program for young men and women preparing for vocations. They are the product of cooperation among secondary and post-secondary educators, working with community representatives. Designed to be only one part of the students' educational experience, they need to be combined with skilled instruction and adequate environment.

Competencies have received much attention in educational literature in recent years. The wide variety of claims for their effectiveness from several sources has tended, sometimes, to either confuse or mislead both the public and professional educators. Experience has taught us that educational improvement cannot be based on a single idea or concept; therefore, these competencies are not the answer to all educational ills. They are, however, a valuable resource for clarifying and validating the instructional process required to produce the skills necessary for today's complex industrial-economic system.

James Travis
Associate Superintendent
for Instruction
Lincoln Public Schools
Lincoln, Nebraska

ACKNOWLEDGEMENTS

The significant contributions of committee members in the development of these materials are greatly appreciated. Members representing four educational agencies, the Lincoln Public Schools, Educational Service Unit No. 6, Southeast Community College, and Boys Town Career Center, combined skills to provide helpful materials for articulation purposes to teachers and administrators.

Persons representing business and industry in Lincoln, Milford, Omaha and other cities in the Educational Service Unit and the Southeast Community College area also contributed expertise through a series of meetings. Vocational teachers from Lincoln and other communities, although not directly involved in the project, made similar contributions as materials were developed.

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INTRODUCTION

Professional staff members of the Lincoln Public Schools, Educational Service Unit No. 6, Boys Town Career Center, and the Southeast Community College have joined with representatives of business and industry in developing these instructional materials.

The educational materials in this guide may be used by administrators, students, and secondary and post-secondary vocational teachers. They are designed to help students move from class to class, grade to grade, secondary studies to post-secondary school or employment. The materials consist of:

1. Student Outcomes
2. Competencies for Job or Advanced Placement
3. Enabling Tasks
4. Glossary of Terms
5. Record of Individual Student Skill Achievement and
6. Class Progress Chart

This information is not limited to a particular vocational course but to a set of competencies. These competencies describe skills necessary for success in initial employment or applicable to advanced placement for educational purposes.

Some schools may be able to provide more opportunities for students to complete competencies and tasks than others. Whatever the case, teachers and administrators will find the materials helpful when planning programs for students and for determining what educational experiences may be made available to them. Students may use the materials to understand and plan the skill developments necessary for employment and additional education.

Teachers and students should keep records of competencies as they develop. Two record forms, one for charting competencies of all students in a class, the other an individual student record, are included in the materials. These records may be used by students and teachers to chart progress toward specific job skills, and as achievement records for presentation with job or post-secondary school applications.

Student Outcomes

Information that will help administrators, teachers and students plan programs at both secondary and post-secondary levels is provided. It applies to:

1. Planning and preparing for job opportunities and placement;

2. Planning and preparing for advanced placement in post-secondary education;

3. Allowing high school credit for previous experience.

"Student outcomes" describe what instruction has prepared a student to do.

JOB OPPORTUNITIES

Many electronic positions available in the Lincoln and Omaha communities and in surrounding areas are listed along with the Dictionary of Occupational Titles and the Office of Education codes.

Recommended competencies to be developed by students for initial employment are given. To better enable them to compete in the electronics job market it is highly recommended that the student also complete courses in advanced algebra, trigonometry and physics. Students may use this information to plan and prepare school experiences properly.

Dictionary of Occupational Titles Code Number	Office of Education Code Classification	Occupational Title	Competencies Necessary for Initial Employment	Recommended Additional Training
710.261-010	17.21	Instrument Repairer	1 - 6	Electromechanical Machinist
710.281-010	17.15	Assembler & Tester, Electronics	1 - 6	Electromechanical
710.281-014	17.15	Electrical Inspector	1 - 6	
710.281-018	17.21	Electromechanical Technician	1 - 6	Machinist Technical Writing
710.381-046		Tester, Electronic Scale	1 - 6	
712.261-010	16.01	Medical-Apparatus Model Maker	1 - 6	Electromechanical Machinist
712.681-022		Medical-Instrument Cable Fabricator	1 - 6	
720.281-010	17.15	Radio Repairer Trouble-shooter	1 - 6	
720.281-014		Tape Recorder Repairer	1 - 6	Electromechanical
722.281-010	17.21	Instrument Repairer	1, 2	Telephone and Telegraph
722.381-010	17.15	Assembler (Telephone and Telegraph) Equipment Wirer	1	
723.381-010	17.02	Electrical Appliance Repair	1, 2	
723.684-010		Assembler Electrical Equipment	1, 2	Electromechanical
724.281-010	17.14	Transformer Tester (Light-Heat-Power)	1, 2, 4	
728.684-010		Cable Maker	1, 2	
729.281-018	17.14	Electric Meter Repairer Apprentice	1, 2, 3, 4	
724.281-030	16.01	Electro-Medical Equipment Repairer	1 - 6	
729.281-038		Relay Tester	1, 2	
729.684-026		Electrical Control Assembler	1, 2	
729.684-058	17.14	Tester Electrical Continuity	1, 2	
821.381-014	17.14	Voltage Tester	2, 3, 4,	

Dictionary of Occupational Titles Code Number	Office of Education Code Classification	Occupational Title	Competencies Necessary for Initial Employment	Recommended Additional Training
822.261-022	17.15	Station Installer and Repairer (Telephone and Telegraph)	2	
822.381.010	17.15	Equipment Installer (Telephone and Telegraph)	1, 2	
823.261-010		Public Address Servicer	1 - 6	
823.261-018		Radio Mechanic	1 - 6	FCC Radio Telephone License 2nd Class
720.281-018	17.15	Television and Radio Repairer	1 - 6	Electromechanical
729.281-010	17.15	Audio-Video Repairer	1 - 6	Electromechanical

ADVANCED PLACEMENT POLICY STATEMENT

Southeast Community College
Lincoln and Milford Campuses

The College believes that students should be recognized and rewarded for previous educational and occupational experience when that experience results in competence in areas normally addressed by the courses and programs of the College. Advanced standing may be awarded with full credit, up to limits established by each department of the College but not exceeding 30 credit hours. Credits earned in other accredited educational institutions in excess of 30 hours may be accepted by the department.

The College has established the following methods to enable students to gain advanced standing:

CREDIT BY EXAMINATION

Some courses have been identified which may be completed by examination. Testing devices and evaluation procedures will vary according to the course, departmental requirements and the amount of credit being advanced.

To apply for credit by examination, the applicant must have been accepted for admission to the College and have established a transcript. Applications for Credit by Waiver or Examination must be submitted to the department from which credit would be granted.

Applicants for credit by examination must pay the following: 50% of the current per credit hour fee for each credit hour attempted by examination. This fee must be paid prior to the examination.

A "Credit by Examination Notice" will be forwarded to the Campus Registrar for all credit granted by examination. The Registrar will record all credit granted as "Px" (Passed by Examination) on the transcript. No honor points will be awarded and the credit by examination will not be included in the cumulative grade point average (CGPA).

CREDIT BY WAIVER

Some courses and series of courses have been identified which may be waived in meeting program graduation requirements.

Students requesting advanced standing Credit by Waiver must: Complete an Application for Credit by Waiver or Examination and submit the application for evaluation to the department granting the waiver.

Upon completion of the evaluation, submit the application and evaluation to the Campus Registrar for recording on their transcript.

The following entry will be made on the student's transcript for all course credit granted by waiver: "The following program requirements were waived by substituting previous education and/or occupational experience. (list courses waived.) This waiver of program requirements was granted this date _____ by _____ (evaluator) and is in accordance with Department, Campus and Area policies, rules and regulations."

No fee will be charged for advanced credit by waiver.

Credit by Waiver will not be included in calculating student's grade point average (CGPA).

Credit granted by waiver is subject to evaluation by other departments, programs and other institutions and probably would not be accepted as transfer credit by them.

Credit granted by waiver will be contingent upon satisfactory completion of advanced courses.

ADVANCED PLACEMENT CREDIT
SOUTHEAST COMMUNITY COLLEGE
LINCOLN CAMPUS

Advanced placement in the Electronics Technology Program of the Lincoln Campus of Southeast Community College will be determined on the basis of competencies which the prospective student demonstrates according to the following:

Students Demonstrating Competency No.	Will Receive SCC Credit in the Amount of	For SCC Course No.	Course Title
1	2 hrs	6185	Basic Soldering For Electronics
2 A, B, & C	1 hr	6161	Test Equipment I
2, D, E, F, G, & H	1 hr	6162	Test Equipment II
3	1.5 hrs	6165	Digital I
4	1.5 hrs	6179	Electronic Circuits
5	1.5 hrs	6179	Electronic Circuits
6	1.5 hrs	6179	Electronic Circuits

The program supervisor of the Electronics Technology Program has the responsibility for conducting and evaluating examinations to determine the competency level of students requesting consideration under this agreement.

Examinations used for evaluation purposes will be updated periodically although every effort will be made to maintain their consistency with the competencies identified in this agreement.

This agreement cannot, however, be considered a contract between Southeast Community College and any prospective student. The Board of Governors of the College reserves the right to make changes in courses required, credits waived, credits granted, and in any other matters it deems necessary without revision of this agreement and without notice. Prospective students wishing consideration under this agreement should contact the program supervisor in order to establish and maintain a close working relationship between the College, its program, and the student.

The student will be required to participate in core area courses in order to successfully meet requirements for graduation. Should the student desire to challenge a course for credit, the "Credit by Examination" procedure will be used. Credits earned by demonstrated student competencies shall apply toward satisfying the present 22 hours of technical electives required for graduation.

The student shall be required to meet any established prerequisites for any courses in which s/he wishes to enroll. To better enable students to meet the prerequisites for electronics courses, it is highly recommended that students complete courses in advanced algebra, trigonometry and physics.

ADVANCED PLACEMENT CREDIT

Southeast Community College
Milford Campus

Advanced placement in the Electrical Technology Program, Electromechanical Technology Program, Electronic Service Program, and the Electronic Engineering Technology Program of the Milford Campus of Southeast Community College will be determined on the following basis:

1. Student must have successfully completed all six competencies in high school and/or demonstrate competency in all six to the Milford Campus program supervisor.

2. Student must have successfully completed high school Math course/courses which provide the mathematical skills taught in the Milford Campus Course #5210101 — Technical Mathematics I and/or demonstrate competency to the Milford Campus program supervisor.

Students meeting the above conditions will receive Southeast Community College, Milford Campus, credit for all courses taught in first quarter, and may begin .esident training at the beginning of second quarter. First quarter courses are:

#5210101 — Technical Mathematics I ..... 3 credits

A basic algebra course that includes scientific notation, conversion of units and graphing. Algebraic processes are covered but emphasis is placed on solving word problems that are typically encountered in electrical/electronic applications. An introduction to right triangle trigonometry is included.

#52101120 — Electrical Principles I Laboratory ..... 8 credits

This course consists of projects to assist the student in learning test equipment operation, circuit construction, schematic reading, and circuit troubleshooting. It also compares experimental results with theoretical calculations obtained from Electrical Principles I Theory course.

#5210121 — Electrical Principles I ..... 8 credits

Characteristics of various components such as resistors, inductors, capacitors and transformers in AC and DC circuitry are studied. The principles learned in this course may be utilized in any program that requires a practical knowledge of electricity.

The program supervisor of the Milford Campus program has the responsibility for conducting and evaluating examinations to determine the competency level of students requesting consideration under this agreement.

Examinations used for evaluation purposes will be updated from time to time although every effort will be made to maintain their consistency with the competencies identified in this agreement.

This agreement cannot, however be considered a contract between Southeast Community College-Milford Campus and any prospective student. The Board of Governors of the College reserves the right to make changes in courses required, courses offered, credits waived, credits granted, and in any other matter it deems necessary without revision of this agreement and without notice. Prospective students wishing consideration under this agreement should contact the program supervisor in order to establish and maintain a close working relationship between the College, its program, and the student.

HIGH SCHOOL CREDIT

High school credits are suggested for each competency. It is the responsibility of each educational agency to determine the level of competency and the amount of credit to be awarded.

Competency	Semester Credit Hours
1	2½
2 A B C	5
2 D E F	5
2 G H	2½
3	10
4	5
5	5
6	5

Competencies

A competency consists of three sections or parts that combine to provide a detailed outline of a major task that a student must accomplish to reach one or more previously stated student outcomes. Competencies are described as follows:

a. Task — What the student must do to demonstrate an ability to do the job.

b. Conditions and Limitations — A description of the circumstances under which the student will demonstrate the skill. Usually included are:

   1. time allowance;
   2. tolerances allowed;
   3. references which may be used;
   4. specific tools and materials to be used (common tool lists are generally omitted unless a required usage is to be demonstrated);
   5. work location (if other than school site);
   6. and, other limitations unique to the task.

c. Criteria of Acceptable Performance — Standards described that constitute acceptable performance. These standards must:

   1. be compatible with the task and the condition;
   2. evaluate all components of the conditions;
   3. include the percentage of responses that must be correct if the competency is primarily cognitive;
   4. and, specify the standard for the criteria. This may take the form of a list of criteria, an instructor's checklist, or references to an authoritative manual such as an automotive flat-rate manual.

Represented in the guide are those competencies needed for initial employment. They are not designated or described by grade level. A student may complete all the competencies available at a school if learning capabilities and time permit.

TASK:

To desolder and solder components.

A. Two Lead Components

CONDITIONS AND LIMITATIONS:

Given the necessary tools and equipment, a printed circuit board(s) containing an assortment of components having two leads, the student will desolder and remove any five 2-lead components. The student will resolder the components to the circuit board. The instructor is to check the board and components after desoldering and again after resoldering. No damage is to occur to components or circuit board. Reference material may not be used. No time limit.

B. Transistors

CONDITIONS AND LIMITATIONS:

Given the necessary tools and equipment, a printed circuit board(s) containing transistors, the student will desolder and remove any five transistors. The student will resolder the transistors to the circuit board. The instructor is to check the board and transistors after desoldering and again after resoldering. Reference material may not be used. No time limit.

C. Integrated Circuits

CONDITIONS AND LIMITATIONS:

Given the necessary tools and equipment, a printed circuit board containing an integrated circuit chip, the student will desolder and remove the IC. The student will resolder the IC to the circuit board. The instructor is to check the board and chip after desoldering and again after resoldering. Reference material may not be used. No time limit.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Desoldered component condition same as when mounted originally.
2. PC board not burnt or cracked or foils lifted.
3. No solder drops or bridges left on PC board; pad holes open.
4. Components left on board not damaged.
5. Resoldered components to have hole in pads filled.
6. Solder to flow away from the component lead in a convex curve.
7. Soldered joint to pass continuity test.

TASK:

COMPETENCY NO. 2

To perform basic operations with test equipment.

A. Meters, Voltage

CONDITIONS AND LIMITATIONS:

Given a VTVM, VOM, and/or DVM, an active circuit containing AC and DC voltages with ten labeled test points, and having both test and reference points identified, the student will make voltage measurements and complete the chart. (Figure 2-1 in test manual). Reference material may not be used. No time limit.

Measurement	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Test Points	A-2									
Voltage	3V									
Range Selected	10V		SAMPLE (Figure 2-1)							
Meter Function AC/DC	AC									

B. Meters, Current

CONDITIONS AND LIMITATIONS:

Given a VOM and/or DVM and an active circuit the student will "break" the circuit at five labeled points and measure the DC current and complete the chart (Figure 2-2 in test manual). Reference material may not be used. No time limit.

Measurement	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Test Points	A									
Current	300 µa		SAMPLE (Figure 2-2)							
Range Selected	1.0 ma									

C. Meters, Resistance

CONDITIONS AND LIMITATIONS:

Given a VTVM, VOM, and/or DVM and a loose assortment of ten resistors, the student will measure the resistance and complete the chart (Figure 2-3 in the test manual). Reference material may not be used. No time limit.

Resistor	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Rated Value	470 ohms									
Tolerance	10%		SAMPLE (Figure 2-3)							
Measured Value	250 ohms									
In/Out of Tolerance	Out									

D. Oscilloscopes, Voltage

CONDITIONS AND LIMITATIONS:

Given an oscilloscope with all front panel controls mis-set and an active circuit, the student will make 5 DC and AC (peak to peak) voltage measurements at labeled test points and complete the chart (Figure 2-4 in test manual). Reference material may not be used. No time limit.

Measurement	#1	#2	#3	#4	#5
Test Points	"A" to Ground				
Measured Voltage	360V	SAMPLE (Figure 2-4)			
Vertical Channel Setting	50 V/CM				
AC/DC	AC				

E. Oscilloscope, Frequency

CONDITIONS AND LIMITATIONS:

Given an oscilloscope with all front panel controls mis-set, and a frequency generator with masked face, (dial setting not visible to student), the student will make three frequency measurements (as set by instructor) and complete the chart (Figure 2-5 in test manual). Reference material may not be used. No time limit.

Generator Setting	#1	#2	#3
Measured Frequency	500Hz	SAMPLE (Figure 2-5)	
Time/Base Setting	2msec/cm		

F. Oscilloscope, Linear Time Base Phase Measurements

CONDITIONS AND LIMITATIONS:

Given an oscilloscope with all front panel controls mis-set, a frequency generator connected to an RC series circuit (resistor: 10K, capacitor: 0.01 microfarad, frequencies: 500, 1000, 5000 hertz). The student will measure the phase angle between E_{gen} and E_r and complete the chart (Figure 2-6 in test manual). Reference material may not be used. No time limit.

Frequency	500Hz	1000Hz	5000Hz
Phase in Degrees	60°	SAMPLE (Figure 2-6)	
Lead/lag with $E_{generator}$ as reference	lead		

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G. Bridge (LCR or Equivalent)

CONDITIONS AND LIMITATIONS:

Given a bridge (LCR or equivalent) with all front panel controls mis-set, three resistors (< 10 Ω, 50 Ω - 100 KΩ, 250 KΩ - 1 MΩ), 3 capacitors (non-electolytic), (470 pF 910 pF, .01MFD, .33MFD, .47 MFD - 1 MFD) and three inductors (56 - 560 μ H, 56 - 560 mH, 1 10 H). The student will use the equipment to complete the chart (Figure 2-7 in test manual). Reference material may not be used. No time limit.

	RESISTORS			CAPACITORS			INDUCTORS		
	#1	#2	#3	#1	#2	#3	#1	#2	#3
Measured Value	1 Ω			.33μFD			2H		

SAMPLE (Figure 2-7)

H. Transistor Tester

CONDITIONS AND LIMITATIONS:

Given a transistor tester and an assortment of NPN and PNP transistors, the student will select and test five transistors and complete the chart (Figure 2-8 in test manual).Reference material may be used. No time limit.

Transistors	#1	#2	#3	#4	#5
Measured Beta	180				
Measured Leakage Current	10 na				
Type NPN/PNP	PNP				

SAMPLE (Figure 2-8)

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. All charts completed with 100% accuracy except measurements to be within a 5% tolerance, for parts A, B, C, D, G and H and 10% for parts E & F.

TASK:

To service basic logic circuits.

A. Gate Testing and Functions Identification

CONDITIONS AND LIMITATIONS:

Given the necessary tools and equipment (proto-board or equivalent), an active TTL or CMOS IC chip (use positive logic), a data sheet, the student will test all gates of IC's listed below for conditions stated in the truth table on the data sheet (Figure 3-1, in test manual).

	FUNCTION	TTL	CMOS
a.	AND	7408 QUAD	4081
b.	OR	7432 (XOR 7486 QUAD)	4071 (XOR 4030)
c.	NAND	7400 QUAD	4011
d.	NOR	7402 QUAD	4001
e.	NOT	7404 Inverter HEX	4069

Reference material may be used. No time limit.

7408 AND

	A	B	Y
GATE 1	0	0	0
	0	1	0
	1	0	1
	1	1	1

	Good	Bad
		X

	C	D	Y
GATE 2	0	0	0
	0	1	0
	1	0	1
	1	1	1

		X

(SAMPLE (Figure 3-1)

	E	F	Y
GATE 3	0	0	0
	0	1	0
	1	0	0
	1	1	1

X	

	G	H	Y
GATE 4	0	0	0
	0	1	0
	1	0	0
	1	1	1

X	

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CRITERIA OF ACCEPTABLE PERFORMANCE:

The student will identify the defective gates with 100% accuracy.

B. Trouble Shooting Active Logic Circuits

CONDITIONS AND LIMITATIONS:

Given the necessary tools and equipment, proto-board or equivalent, data sheets and an active logic circuit composed of two chips (both TTL or both CMOS) from part A (IC list: a, b, c, d, e), interconnected utilizing two gates per chip with one or more malfunctions, the student will write the Boolean truth table to determine circuit function and monitor gate inputs and outputs to isolate circuit malfunction. Any chip(s) found to be defective must be replaced with a direct replacement and circuit checked for function to match truth table. Reference material may be used. No time limit.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Truth table written with 100% accuracy.
2. Truth table verified using Boolean algebra with 100% accuracy.
3. Defective gates identified with 100% accuracy.

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TASK:

To service DC power supplies.

CONDITIONS AND LIMITATIONS:

Given a power supply (half wave, full wave, or bridge) with one or more malfunctions, necessary tools and equipment, the student will trace the circuit, draw the schematic, identify each component, explain its function, correct the malfunction(s), and complete the chart (Figure 4-1 in test manual) for any component removed for testing. Reference materials may be used only while correcting the malfunction(s). No time limit.

	Component Identification	Specifications and Ratings	Reason Checked	Results
1	R_1	500 Ω 5W	Suspected open	R_1 checks OK
2				
3				
4				
5				

SAMPLE (Figure 4-1)

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Schematic drawn with 100% accuracy.
2. Components (R_1, C_1, etc.), in the power supply identified with 100% accuracy.
3. Function of all components explained with 90% accuracy.
4. Any malfunction in the power supply corrected. Only one malfunction is required for sufficient evaluation.
5. Chart completed for all component(s) removed. Only those components suspected of having a malfunction to be removed. Identification of component(s) (R_1, C_5, etc.), specifications and ratings, reason for being suspected faulty, and specific results of testing included. No more than five components per circuit to be removed for testing to isolate malfunction(s).
6. Replacement of defective components requiring desoldering and soldering according to Competency No. 1.

TASK:

To service solid state amplifiers (AF/RF)

CONDITIONS AND LIMITATIONS:

Given at least two AF and one RF amplifier circuits, with at least one malfunctioning component in each circuit, necessary tools and equipment, the student will trace the circuit, draw the schematics, identify all components and explain the function of the major components. For each of the following amplifiers, correct any malfunctions and complete the charts (Figure 5-1 in test manual) for all components removed when testing:

a. linear integrated circuit amplifier (RF or AF)

b. bi-polar junction transistor amplifier (AF or RF)

c. field effect transistor amplifier (AF or RF)

Reference material may be used only while correcting malfunction(s). No time limit.

_____ **AMPLIFIER**

	Component Identification	Specifications and Ratings	Reason Checked	Results
1	IC_5	BA511	input but no output	IC_5 replaced but problem remains
2				
3				
4				
5				

SAMPLE (Figure 5-1)

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Schematic drawn with 100% accuracy.
2. Components (R_1, C_1, etc.) in the amplifier identified with 100% accuracy.
3. Function of all major components explained with 90% accuracy.
4. Charts completed for all components removed. Only those components suspected of having a malfunction to be removed. Identification of components (R_1, C_5, etc.), specifications and ratings, reason for being suspected faulty, and specific results of testing included. To isolate malfunctions, no more than 5 components per circuit to be removed for testing.
5. Malfunctions corrected and amplifiers functioning within design paramaters.
6. Replacement of defective components requiring desoldering and soldering according to Competency No. 1.

TASK:

To service solid state oscillator circuits.

A. Constructing and Testing

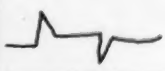
CONDITIONS AND LIMITATIONS:

Given the necessary tools and equipment, 10:1 oscilloscope probe, components, schematics, and parts list, the student will check the individual components (optional), breadboard and test the following oscillators:

a. Multivibrator
b. RC Phase Shift
c. Hartley or Colpitts
d. Crystal

Complete the charts in the test manual (Figure 6-1 & 6-2). Reference materials may be used. No time limit.

AC OUTPUT

Oscillator	SCOPE			VTVM
	Wave Form	Frequency	P-P Voltage	AC Voltage
Multi-vibrator		400Hz	4V	1.6V
RC Phase Shift				
Hartley or Colpitts				
Crystal				

SAMPLE (Figure 6-1)

DC VOLTAGE READINGS TO GROUND

Multivibrator						RC Phase Shift			Hartley or Colpitts			Crystal		
Q_1			Q_2			Q_1			Q_1			Q_1		
E	B	C	E	B	C	E	B	C	E	B	C	S	G	D
OV	.7V	4.6V	OV	.6V	4.8V									

SAMPLE (Figure 6-2)

CRITERIA OF ACCEPTABLE PERFORMANCE:

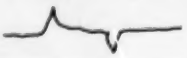
1. Breadboard circuit constructed with 100% accuracy.
2. The student will complete the charts in the test manual with 100% accuracy.

B. Trouble Shooting

CONDITIONS AND LIMITATIONS:

Given the four oscillator circuits from Part "A" with at least one malfunctioning component in each circuit, necessary tools and equipment, 10:1 oscilloscope probe, the student will complete the "Preliminary Measurement Chart" (Figure 6-3 & 6-4), "Component Removed for Testing Chart" (Figure 6-5), correct any malfunctions, and after repair is completed, complete the "Post Repair Chart" (Figure 6-6 & 6-7) for each circuit. Reference materials may be used. No time limit.

AC OUTPUT CHART

	SCOPE			*VTVM*
Oscillator	Wave Form	Frequency	P-P Voltage	AC Voltage
Multi-vibrator		400Hz	4 V	1.6V
RC Phase Shift		SAMPLE (Figure 6-3 & 6-6)		
Hartley or Colpitts				
Crystal				

DC VOLTAGE READINGS TO GROUND

Multivibrator						RC Phase Shift			Hartley Colpitts			Crystal		
Q_1			Q_2			Q_1			Q_1			Q_1		
E	B	C	E	B	C	E	B	C	E	B	C	S	G	D
OV	.7V	4.6V	OV	.6V	4.8V	SAMPLE (Figure 6-6 & 6-7)								

*the above charts are samples of the charts to be used for preliminary measurements and post repair conformation.

COMPONENTS REMOVED FOR TESTING

_____ Oscillator

	Component Identification	Specifications and Ratings	Reason Checked	Results
1	Q_1	ECG 123A	not oscillating	Q_1 checks OK
2				
3				
4		SAMPLE (Figure 6-5)		
5				

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Charts (Figures 6-3 through 6-7) completed, malfunctions corrected and the oscillator is functioning within design parameters.
2. No more than five components per circuit to be removed for testing to isolate malfunction(s).
3. Replacement of defective components requiring desoldering and soldering according to Competency No. 1.

Enabling Tasks

The enabling tasks are the activities necessary for developing a job skill. The completion of all enabling tasks for a competency leads to achievement of that competency. They may become daily or weekly lesson plans if teachers develop conditions and criteria similar to those developed for the competencies. The enabling tasks have been suggested by people in business and industry.

COMPETENCY No. 1 — TO DESOLDER AND SOLDER COMPONENTS

- Solder and desolder components
  - resistors
  - capacitors (electrolytic)
  - capacitors (non-electrolytic)
  - inductors
  - fuse, pig tail
  - line cords
  - transistors
  - integrated circuit
  - tube sockets
  - transistor sockets
  - integrated circuit sockets
  - switches
  - circuit breaker
  - conductors
  - components to terminal strip
  - components to printed circuit board
  - diodes
- Replace soldering gun tip
- Replace soldering pencil tip
- Replace soldering pencil heating element
- Use and care of desoldering and soldering aids
- Use solder wick
- Select correct solder
- Desolder and solder grounding straps
- Tinning
  - wire
  - soldering tip
- Use heat sinks while soldering and desoldering
- Visually inspect and repair circuit board
  - Solder connections
    - grainy
    - cracks
    - oxidation
    - opens
    - bridges
    - lifted foils
    - pad holes filled
    - solder flow
    - burns or discoloration
    - broken wires
    - cold solder joints
    - breaks in foil
    - feed-throughs for solder starvation
  - Circuit board components
    - cracks in board
    - shorts and opens
    - broken, charred or damaged components
    - frayed wires
    - melted insulation

Check components for "shorts," "opens" and damage
- line cord and plug
- diodes
- electrolytic capacitors
- non-electrolytic capacitors
- inductors
- resistors
- transistors
- IC's

Use and care of hand tools
- diagonal pliers
- long nose pliers
- wire stripper
- IC insertion and extractor tool

COMPETENCY No. 2 — TO PERFORM BASIC OPERATIONS WITH TEST EQUIPMENT

Check components for "shorts," "opens" and damage
- line cord and plug
- circuit breaker
- fuse

Substitute or bridge components
- fuse
- circuit breaker

Use and care of hand tools
- calculator

Use and care of repair aids
- contact cleaner
- test equipment manuals

Perform routine calibration
- VOM
- VTVM
- DVM
- LCR bridge
- oscilloscope
- transistor checker
- signal generator

Use of test equipment
- VOM, DVM, VTVM to measure:
  - DC voltage
  - ripple voltage
  - load current directly
  - AC voltage
  - continuity checks
  - resistance
- oscilloscope to measure:
  - AC volts peak to peak (1:1 & 1:10 probes)
  - DC volts
  - frequency on linear time base
  - phase relations of RC series circuits using linear time base
  - signal voltages
  - ripple voltage
- LCR bridge to measure:
  - capacitors
  - inductors
  - resistors
- solid state devices checker to measure:
  - device type (NPN - PNP)
  - DC beta
  - leakage current

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COMPETENCY No. 3 — TO SERVICE BASIC LOGIC CIRCUITS

- Solder and desolder components
  - resistors
  - capacitors (electrolytic)
  - capacitors (non-electrolytic)
  - inductors
  - line cords
  - transistors
  - integrated circuit
  - transistors sockets
  - integrated circuit sockets
  - switches
  - circuit breaker
  - conductors
  - components to terminal strip
  - components to printed circuit board
  - diodes
- Replace soldering gun tip
- Replace soldering pencil tip
- Replace soldering pencil heating element
- Use and care of desoldering and soldering aids
- Use solder wick
- Select correct solder
- Desolder and solder grounding straps
- Tinning
  - wire
  - soldering tip
- Use heat sinks while soldering
- Visually inspect and repair circuit board
  - Solder connections
    - grainy
    - cracks
    - oxidation
    - opens
    - bridges
    - lifted foils
    - pad holes filled
    - solder flow
    - burns or discoloration
    - broken wires
    - cold solder joints
    - breaks in foil
    - feed-throughs for solder starvation
  - Circuit board components
    - cracks in board
    - missing components
    - shorts and opens
    - broken, charred or damaged components
    - oozing electrolytics
    - wax dripping from transformer
    - carbon paths
    - frayed wires
    - melted insulation
  - Live circuit inspections
    - listen for "pops and sizzles"
    - perform "sniff" test
    - perform "touch" test
    - look for smoke, melting insulation, and arc

- Check components for "shorts," "opens" and damage
  - line cord and plug
  - circuit breaker
  - fuse
  - thermistor
  - diodes
  - transformers
  - electrolytic capacitors
  - non-electrolytic capacitors
  - inductors
  - resistors
  - transistors
  - IC's
  - switches
  - indicator light
- Substitute or bridge components
  - electrolytics
  - fuse
  - circuit breaker
  - switch
- Use and care of hand tools
  - calculator
  - diagonal pliers
  - long nose pliers
  - wire stripper
  - crimpers
  - wire wrapping tool
  - IC insertion and extractor tool
- Use and care of repair aids
  - contact cleaner
  - freeze mist
  - heat gun
  - service manuals
  - silicone grease
  - solid state substitution manuals
  - data book
  - Boolean Algebra
  - DeMorgan's Theorem
  - test equipme... manuals
- Perform routine calibration
  - VOM
  - VTVM
  - DVM
  - LCR bridge
  - oscilloscope
  - transistor checker
  - IC tester
- Use of test equipment
  - VOM, DVM, VTVM to measure:
    - DC voltage
    - ripple voltage
    - load current directly
    - AC voltage
    - continuity checks
    - resistance

- oscilloscope to measure:
  - AC volts peak to peak (1:1 & 1:10 probes)
  - DC volts
  - frequency on linear time base
  - phase relations of RC series circuits using linear time base
  - signal voltages
  - ripple voltage
  - load current indirectly
  - monitor data pulses
- LCR bridge to measure
  - capacitors
  - inductors
  - resistors
- solid state devices checker to measure
  - device type (NPN - PNP)
  - DC beta
  - leakage current
  - IC's
- logic probe and pulser
- DC power supply (TTL compatible)
- variable AC transformer

Read and draw schematics
Identify pin placement and socket numbers of IC's

COMPETENCY No. 4 — TO SERVICE DC POWER SUPPLY

Solder and desolder components
- resistors
- capacitors (electrolytic)
- capacitors (non-electrolytic)
- inductors
- fuse, pig tails
- line cords
- transistors
- integrated circuit
- tube sockets
- transistor sockets
- integrated circuit sockets
- switches
- circuit breaker
- conductors
- components to terminal strip
- components to printed circuit board
- diodes

Replace soldering gun tip
Replace soldering pencil tip
Replace soldering pencil heating element
Use and care of desoldering and soldering aids
Use solder wick
Select correct solder
Desolder and solder grounding straps
Tinning
- wire
- soldering tip

Use heat sinks while soldering

- Visually inspect and repair circuit board
  - Solder connections
    - grainy
    - cracks
    - oxidation
    - opens
    - bridges
    - lifted foils
    - pad holes filled
    - solder flow
    - burns or discoloration
    - broken wires
    - cold solder joints
    - breaks in foil
    - feed-throughs for solder starvation
  - Circuit board components
    - cracks in board
    - missing components
    - shorts and opens
    - broken, charred or damaged components
    - oozing electrolytics
    - wax dripping from transformer
    - carbon paths
    - frayed wires
    - melted insulation
  - Live circuit inspection
    - listen for "pops and sizzles"
    - perform "sniff" test
    - perform "touch" test
    - look for smoke, melting insulation and arcs
- Check components for "shorts," "opens" and damage
  - line cord and plug
  - circuit breaker
  - fuse
  - VDR
  - thermistor
  - diodes
  - transformers
  - electrolytic capacitors
  - non-electrolytic capacitors
  - inductors
  - resistors
  - transistors
  - IC's
  - switches
  - indicator light
- Substitute or bridge components
  - electrolytics
  - fuse
  - circuit breaker
  - switch
- Use and care of hand tools
  - calculator
  - diagonal pliers
  - long nose pliers
  - wire stripper
  - crimpers
  - wire wrapping
  - IC insertion and extractor tool

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Use and care of repair aids
- contact cleaner
- freeze mist
- heat gun
- service manuals
- silicone grease
- solid state substitution manuals
- data book
- test equipment manuals

Perform routine calibration
- VOM
- VTVM
- DVM
- LCR bridge
- oscilloscope
- transistor checker
- IC tester

Use of test equipment
- VOM, DVM, VTVM to measure:
  - DC voltage
  - ripple voltage
  - load current directly
  - AC voltage
  - continuity checks
  - resistance
- oscilloscope to measure:
  - AC volts peak to peak (1:1 & 10:1 probes)
  - DC volts
  - ripple voltage
  - load current indirectly
- LCR bridge to measure:
  - capacitors
  - inductors
  - resistors
- solid state devices checker to measure:
  - device type (NPN - PNP)
  - DC beta
  - leakage current
  - IC
- variable AC transformer

Read and draw schematics

Identify pin placement and numbers of IC's

COMPETENCY No 5 — TO SERVICE SOLID STATE AMPLIFIERS (AF or RF)

Solder and desolder components
- resistors
- capacitors (electrolytic)
- capacitors (non-electrolytic)
- inductors
- fuse, pig tail
- line cords
- transistors
- integrated circuit
- tube sockets
- transistor sockets
- integrated circuit sockets
- switches

- circuit breakers
- conductors
- components to terminal strip
- components to printed circuit board
- diodes

Replace soldering gun tip
Replace soldering pencil top
Replace soldering pencil heating element
Use and care of desoldering and soldering aids
Use solder wick
Select correct solder
Desolder and solder grounding straps
Tinning
- wire
- soldering tip

Use heat sinks while soldering
Visually inspect and repair circuit board
- Solder connections
  - grainy
  - cracks
  - oxidation
  - opens
  - bridges
  - lifted foils
  - pad holes filled
  - solder flow
  - burns or discoloration
  - broken wires
  - cold solder joints
  - breaks in foil
  - feed-throughs for solder starvation
- Circuit board components
  - cracks in board
  - missing components
  - shorts and opens
  - broken, charred or damaged components
  - oozing electrolytics
  - wax dripping from transformer
  - carbon paths
  - frayed wires
  - melted insulation
- Live circuit inspection
  - listen for "pops and sizzles"
  - perform "sniff" test
  - perform "touch" test
  - look for smoke, melting insulation and arcs

Check components for "shorts," "opens" and damage
- line cord and plug
- circuit breaker
- fuse
- VDR
- thermistor
- diodes
- transformers
- electrolytic capacitors
- non-electrolytic capacitors
- inductors
- resistors
- transistors

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- IC's
- switches
- indicator
- speakers

Substitute or bridge components
- electrolytics
- fuse
- circuit breakers
- switch

Use and care of hand tools
- calculator
- diagonal pliers
- long nose pliers
- wire stripper
- crimpers
- wire wrapping tool
- IC insertion and extractor tool

Use and care of repair aids
- contact cleaner
- freeze mist
- heat gun
- service manuals
- silicone grease
- solid state substitution manuals
- data book
- test equipment manuals

Perform routine calibration
- VOM
- VTVM
- DVM
- LCR bridge
- oscilloscope
- transistor checker
- signal generator
- IC tester
- 10:1 scope probe compensation

Use of test equipment
- VOM, DVM, VTVM to measure:
  - DC voltage
  - ripple voltage
  - load current directly
  - AC voltage
  - continuity checks
  - resistance
- oscilloscope to measure:
  - AC volts peak to peak (1:1 & 10:1 probes)
  - DC volts
  - signal voltages
  - ripple voltage
  - load current indirectly
  - gain of stage
- LCR bridge to measure:
  - capacitors
  - inductors
  - resistors
- solid state devices checker to measure:
  - device type (NPN - PNP)
  - DC beta
  - leakage current
  - IC's

- signal generator to measure gain of stage
- variable AC transformer
- signal tracer to measure gain of stage and trace signal

Read and draw schematics
Identify pin placement socket and numbers of IC's

COMPETENCY No. 6 — TO SERVICE SOLID STATE OSCILLATOR CIRCUITS

Solder and desolder components
- resistors
- capacitors (electrolytic)
- capacitors (non-electrolytic)
- inductors
- fuse, pig tail
- line cords
- transistors
- integrated circuit
- tube sockets
- transistor sockets
- integrated circuit sockets
- switches
- circuit breaker
- conductors
- components to terminal strip
- components to printed circuit board
- diodes

Replace soldering gun tip
Replace soldering pencil tip
Replace soldering pencil heating element
Use and care of desoldering and soldering aids
Use solder wick
Select correct solder
Desolder and solder grounding straps
Tinning
- wire
- soldering tip

Use heat sinks while soldering
Visually inspect and repair circuit board
- Solder connections
  - grainy
  - cracks
  - oxidation
  - opens
  - bridges
  - lifted foils
  - pad holes filled
  - solder flow
  - burns or discoloration
  - broken wires
  - cold solder joints
  - breaks in foil
  - feed-throughs for solder starvation

- Perform routine calibration
  - VOM
  - VTVM
  - DVM
  - LCR bridge
  - oscilloscope
  - transistor checker
  - signal generator
  - IC tester
  - 10:1 scope probe compensation
- Use of test equipment
  - VOM, DVM, VTVM to measure:
    - DC voltage
    - ripple voltage
    - load current directly
    - AC voltage
    - continuity checks
    - resistance
  - oscilloscope to measure:
    - AC volts peak to peak (1:1 & 1:10 probes)
    - DC volts
    - frequency on linear time basis
    - signal voltages
    - ripple voltage
    - load current indirectly
    - gain of stage
  - LCR bridge to measure:
    - capacitors
    - inductors
    - resistors
  - solid state devices checker to measure:
    - device type (NPN-PNP)
    - DC beta
    - leakage current
    - IC's
  - signal generator to measure gain of stage
  - variable AC transformer
  - signal tracer to measure gain of stage and trace signal
- Read and draw schematics
- Identify pin placement and socket numbers of IC's
- Circuit board components
  - cracks in board
  - missing components
  - shorts and opens
  - broken, charred or damaged components
  - oozing electrolytics
  - wax dripping from transformer
  - carbon paths
  - frayed wires
  - melted insulation
- Live circuit inspection
  - listen for "pops and sizzles"
  - perform "sniff test"
  - perform "touch test"
  - look for smoke, melting insulation and arcs

Check components for "shorts" and "opens" and damage
- line cord and plug
- circuit breaker
- fuse
- VDR
- thermistor
- diodes
- transformers
- electrolytic capacitors
- non-electrolytic capacitors
- inductors
- resistors
- transistors
- IC's
- switches
- indicator

Substitute or bridge components
- electrolytics
- fuse
- circuit breaker
- switch
- crystals

Use and care of hand tools
- calculator
- diagonal pliers
- long nose pliers
- wire stripper
- crimpers
- wire wrapping tool
- IC insertion and extractor

Use and care of repair aids
- contact cleaner
- freeze mist
- heat gun
- service manuals
- silicone grease
- solid state substitution manuals
- data book
- test equipment manuals

Glossary

Items included are subject to different interpretations. These definitions are applicable for use in context of this material.

GLOSSARY

Active Circuit
Operational circuit — may or may not be within specifications.

Basic Operations
Normal set up and application techniques associated with the use of test equipment.

Breadboard Circuit
Circuit which the student builds with components provided by the instructor.

Crimpers
A special tool used for solderless connectors.

Discrete
Separate components such as a resistor, capacitor, inductor, or transistor as opposed to an interegrated circuit (circuit on a chip).

Faulty
Open, shorted, or intermittent components that disrupt circuit operation within its design parameters.

Labeled Test Points
Test points in a circuit where the student is to take voltage and/or current measurements.

Loose Assortment
A variety of passive or active components which are not soldered or plugged into a circuit board or are not interconnected in any manner.

Major Components
Components essential to circuit operation.

Malfunction
Any circuit disorder which prevents the circuit from operating within design specifications.

Mis-set
The controls of the test equipment are intentionally mis-adjusted by the instructor.

Necessary Tools and Equipment
Hand tools, soldering equipment, test equipment and support items required to complete the task.

No Reference Materials May Be Used
Notes, data books, text/lab books are not allowed. The student is to perform based upon his knowledge.

Parameter
Minimum and maximum range of frequencies and characteristics within which the circuit must operate to be considered as within specifications.

Specifications and Ratings
Nominal value and tolerances of passive components, voltage ratings, working voltage ratings and current ratings of transistors, IC's, resistors, capacitors, and inductors.

Individual Student Record

A complete and accurate record may be used by students for job applications and for planning post-secondary education. For reference purposes, photocopies of individual student records may be given to the student. Original copies of all records should remain in the Student Services Department of the school.

ELECTRONICS

Name of Student

School Stamp

This is to certify that the above named student has demonstrated proficiency in the following tasks:

Comp	Task	Date Completed	Instructor
1	Desolder and Solder Components A. Two Lead Components B. Transistors C. Integrated Circuits		
2	Perform Basic Operations With Test Equipment A. Meters, Voltage B. Meters, Current C. Meters, Resistance D. Oscilloscopes, Voltage E. Oscilloscope, Frequency F. Oscilloscope, Linear Time Base Phase Measurements G. Bridge (LCR or Equivalent) H. Transistor Tester		
3	Service Basic Logic Circuits A. Gate Testing and Functions Identification B. Trouble Shooting Active Logic Circuits		
4	Service DC Power Supplies		
5	Service Solid State Amplifiers (AF/RF)		
6	Service Solid State Oscillator Circuits A. Constructing and Testing B. Trouble Shooting		

School Official Signature

Student Signature

Class Competency Record

It is important that complete and accurate competency records be maintained for all students. Teachers, administrators, students and people in business and industry may benefit from this information.

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ELECTRONICS

STUDENT RECORD CLASS ROSTER

	Two Lead Components	Transistors	Integrated Circuits	Meters, Voltage	Meters, Current	Meters, Resistance	Oscilloscopes, Voltage	Oscilloscope, Frequency	Oscilloscope, Linear Time Base Phase Measurements	Bridge (LCR or Equivalent)	Transistor Tester	Gate Testing and Functions Identification	Trouble Shooting Active Logic Circuits	Service DC Power Supply	Service Solid State Amplifiers (AF or RF)	Constructing and Testing	Trouble Shoo.ng									
	1			2								3		4	5	6									
	A	B	C	A	B	C	D	E	F	G	H	A	B			A	B								

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